CUHK Jockey Club Initiative Gaia

Go Green Community —
Jockey Club Carbon Reduction Partnership Scheme

# Carbon Audit Benchmarking Report

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## Section 1 Introduction

### 1.1 Preamble

1.1.1 CUHK Jockey Club Initiative Gaia (Gaia) is a 5-year community engagement programme launched in 2012 by The Chinese University of Hong Kong (CUHK), with a donation of HK$70 million by The Hong Kong Jockey Club Charities Trust (HKJC). Committed to paving a sustainable future for Hong Kong, Gaia aims at promoting environmental conservation and sustainability in local communities, through knowledge transfer, public education and a carbon reduction partnership with schools and non-governmental organizations (NGOs).

1.1.2 Established under Gaia, the Go Green Community – Jockey Club Carbon Reduction Partnership Scheme（綠色社群——賽馬會減碳伙伴計劃）(the Scheme) engages schools and NGOs to reduce carbon emissions in Hong Kong. Minimizing greenhouse gas (GHG) or carbon emissions is the most direct and relevant measure to combat climate change—the environmental challenge of our time. Effective carbon management and reduction will not only cut costs of operation, but also help achieve a sustainable future.

1.1.3 The Scheme is designed to include two phases: the Pilot Phase (2012–2014) and the Second Phase (2014–2017). During the Pilot Phase of the Scheme, the professional Go Green Team of CUHK conducted carbon audit for 33 schools (Appendix A) and eight NGOs (Appendix B), to determine the extent and source of emissions from the schools and NGOs and identify opportunities where emissions can be reduced.

### 1.2 The Report

1.2.1 This carbon audit benchmarking report documents the findings of carbon audit conducted by the Go Green Team at those 41 schools and NGOs during the Pilot Phase of the Scheme[1].

1.2.2 The objectives of the report are:

(a) To summarize the extent and source of carbon emissions from the schools and NGOs based on the carbon audit results

(b) To enable the schools and NGOs to share best practices and benchmark themselves against their peers

(c) To assist the schools and NGOs to, based on the sharing and benchmarking, devise their own strategic plans on carbon reduction

[1] Each school and NGO is presented with, additional to this benchmarking report, a carbon audit report summarizing the findings and results of the audit, with tailor-made recommendations to reduce carbon emission in the school or organization.

## Section 2 Methodology

### 2.1 Standards and Scope

2.1.1 The Go Green Team adopts a systematic and scientific approach to account for and report on carbon emissions of the schools and NGOs in this carbon audit exercise, making reference to the *Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong* (2010 Edition) (the Guidelines) published by the Environmental Protection Department (EPD) and the Electrical and Mechanical Services Department (EMSD).

2.1.2 In accordance with the Guidelines, the scope of carbon audit is defined in **Table 1** below.

| Scope | Definition |
|---|---|
| Period under Carbon Audit | School Year or Financial Year 2011/12 |
| Physical Boundary | The office/facility area occupied by the schools/NGOs, in accordance with the floor layout plans and information provided by the schools/NGOs |
| Operational Boundary | Three categories, in accordance with the Guidelines:<br>• Scope 1: Direct Emissions and Removals<br>  ○ GHG emissions from sources and removals by sinks under control by the reporting entity and within the physical boundary of the building concerned<br>• Scope 2: Energy Indirect Emissions<br>  ○ GHG emissions from the generation of purchased electricity and/or town gas that is consumed by equipment controlled by the reporting entity or the reporting entity's operations within the physical building boundary<br>• Scope 3: Other Indirect Emissions<br>  ○ GHG emissions associated with reporting entity activities other than those defined under Scope 2 |

**Table 1** Scope of Carbon Audit

2.1.3 Emission factors included in the Guidelines are up to the year of 2008; updated emission factors are collated by the Go Green Team and applied in the carbon audit exercise as necessary. Where appropriate, additional emission factors, definitions and standards published by other professional bodies are referred to in order to supplement any information gap identified. A complete list of emission factors applied in the carbon audit exercise is given in Appendix C.

## 2.2 Procedures

2.2.1 The carbon audit procedures are summarized in **Table 2** below.

| Step | Item | Action |
|---|---|---|
| I | Data Collection | Collect and review essential information provided by the school or NGO prior to the carbon audit visit |
| II | Carbon Audit Visit | Conduct carbon audit visit, including meeting with the responsible school or NGO staff, verification of collected data, identification of emission sources, and collection of facilities information |
| III | Data Analysis | Analyze carbon emission from different emission sources and identify targets for carbon reduction |
| IV | Carbon Audit Report Preparation | Prepare for the school's or NGO's consideration a carbon audit report with tailor-made recommendations |
| V | Carbon Audit Report Presentation | Conduct a face-to-face presentation of the carbon audit report to the school or NGO, to discuss the audit results and recommendations |
| VI | Follow-up | Follow up the implementation of recommended carbon reduction measures |

**Table 2** Procedures of Carbon Audit

## 2.3 Carbon Inventory

2.3.1 Based on the scope and procedures, as well as subsequent results, of the carbon audit exercise, a carbon inventory is established. A carbon inventory is an accounting of GHGs emitted to the atmosphere over a period of time. It can be used by management and policy makers to track an entity's emissions, set reduction targets, develop reduction strategies, policies and action plans, and monitor progress. The inventory results can also be used for **benchmarking** performance over time.

## Section 3 Go Green Schools Benchmarking

### 3.1 Total Carbon Emission of the Schools

3.1.1 In this report, the carbon audit results of the 33 schools are compared, analyzed and benchmarked. Appendix D is a carbon inventory of the schools in 2011/12 (the baseline year of the inventory, which is to be updated when a further round of carbon audit completes), for individual schools' understanding of their current situation as compared with others[2].

3.1.2 **Figure 1** shows the total carbon emission (i.e. all three scopes; see Table 1 above) of the schools in an ascending order. Among the 33 schools, the lowest total carbon emission recorded is 189.39 tonnes of $CO_2e$ and the highest is 732.35 tonnes of $CO_2e$.

3.1.3 The average total carbon emission of the 33 schools is 364.26 tonnes of $CO_2e$. More than half (18, or 54.54%) of the schools' total carbon emission is lower than average.

3.1.4 The median of the schools' total carbon emission is 361.52 tonnes of $CO_2e$, which is very close to the value of average total carbon emission, indicating that the data are evenly distributed.

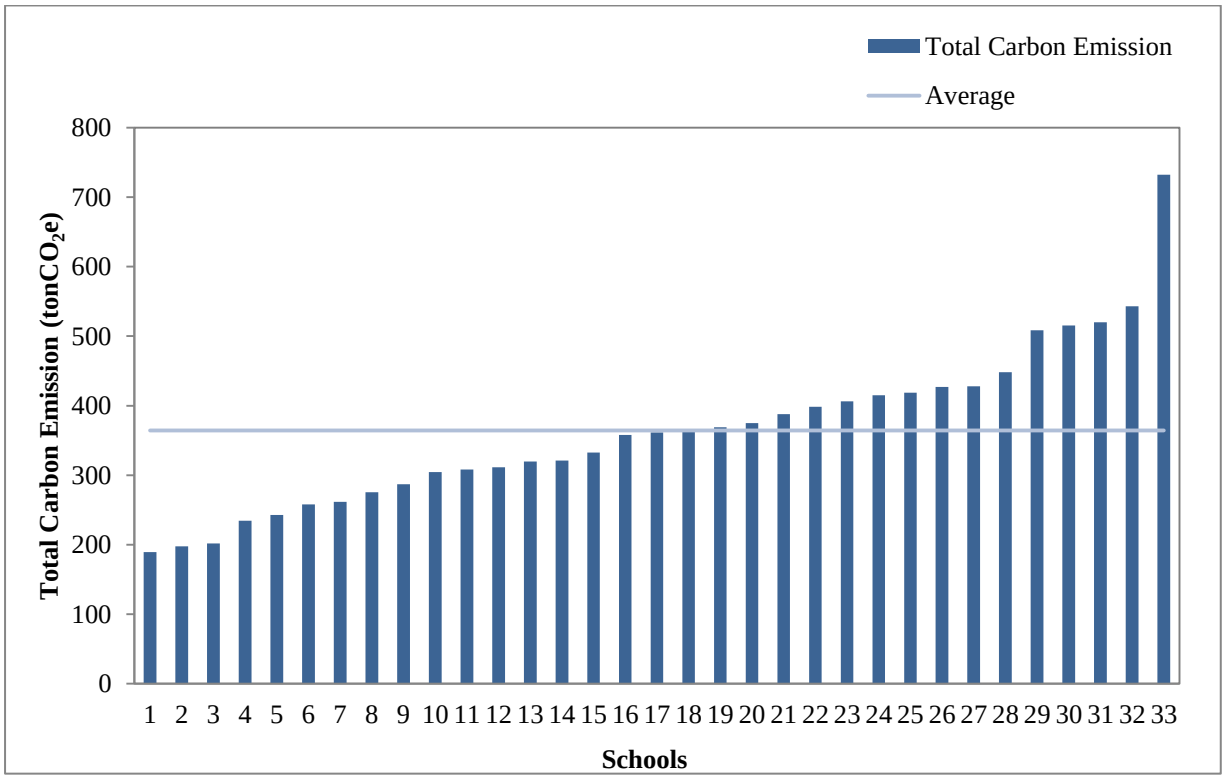


**Figure 1** Total Carbon Emission of Schools Listed in Ascending Order

[2] Appendix D is compiled on an anonymous basis, but a school may refer to its own carbon audit report to identify itself from the inventory.

3.1.5 **Figure 2** categorizes the schools' total carbon emission into "Low" (below the 25$^{th}$ percentile), "Medium" (between the 25$^{th}$ and 75$^{th}$ percentiles) and "High" (above the 75$^{th}$ percentile) levels.

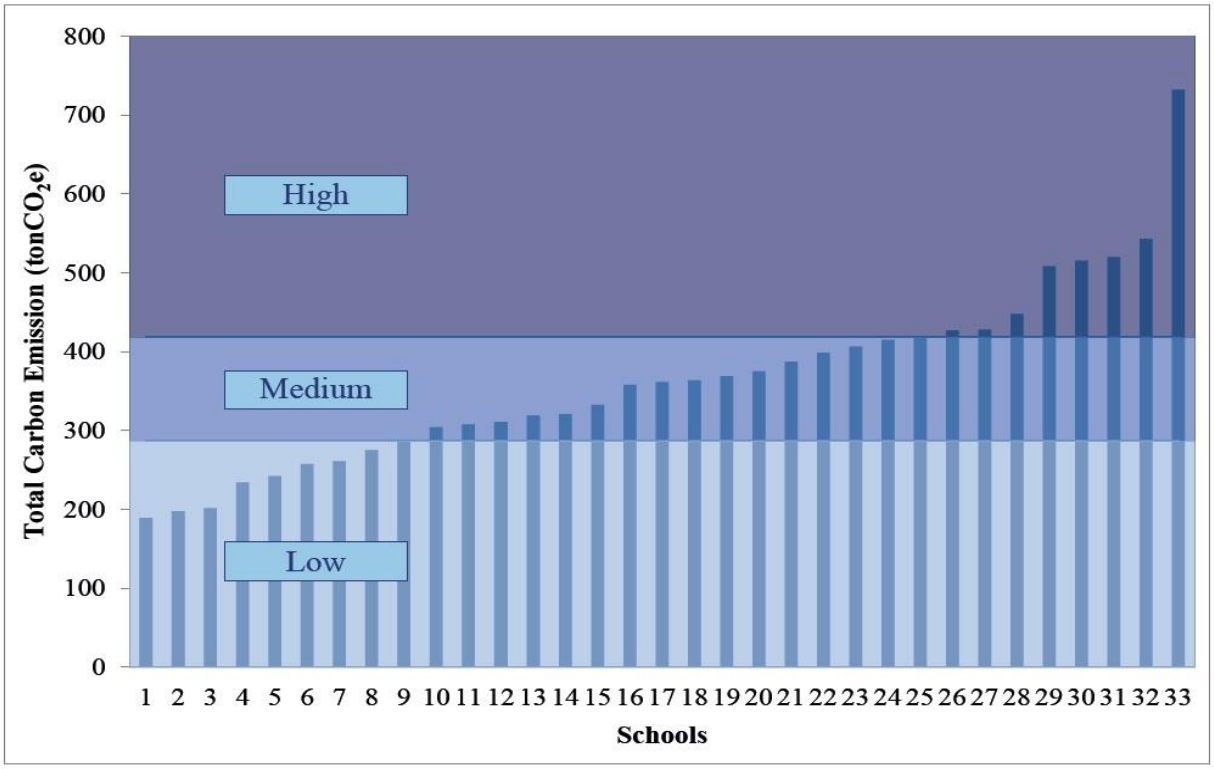


**Figure 2** Total Carbon Emission of Schools Categorized into Low, Medium and High Levels

3.1.6 **Figure 3** shows the distribution of schools according to the total carbon emission level categorized into 100-ton$CO_2$e intervals. It is found that 300–400 tonnes of $CO_2$e recorded the highest frequency (13 schools).

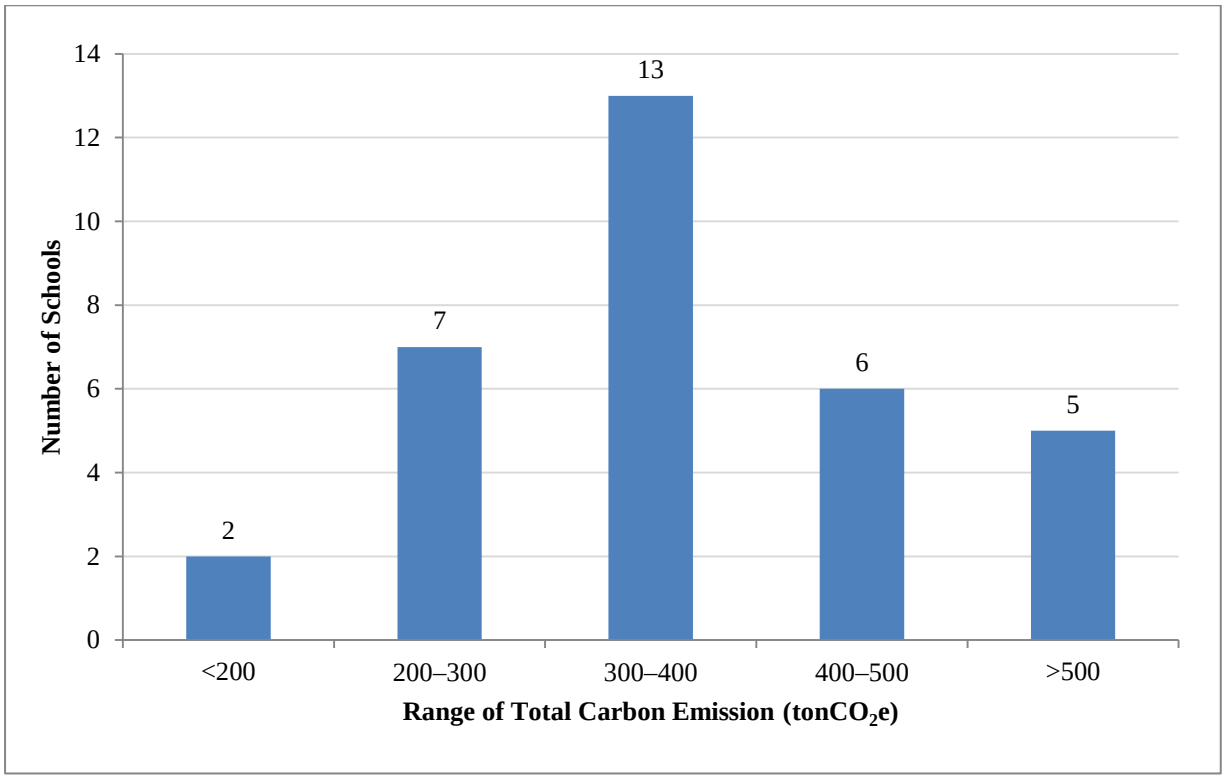


**Figure 3** Distribution of Schools by Total Carbon Emission

3.1.7 For a meaningful and accurate benchmarking of carbon emission performance, the size of the school, in both terms of people (number of students, teachers and staff) and physical area, should also be taken into consideration. In this connection, and also to facilitate schools in the formulation of appropriate carbon reduction targets and plans, the ensuing paragraphs illustrate the schools' per capita and per square metre carbon emission levels.

## 3.2 Carbon Emission Per Person

3.2.1 The number of users, generally speaking, correlates positively with the total carbon emission; therefore, in most cases, the more students, teachers and staff a school has, the more likely that its total carbon emission is high.

3.2.2 As shown in **Figure 4**, with a few exceptions, a positive relationship between the number of users and the total carbon emission of these 33 schools is noted. There are a number of cases in which the schools, despite their large student and teacher population, performed considerably well in maintaining a low-carbon operation. It is also observed that some schools have similar numbers of users, but their total carbon emission levels vary greatly. Possible explanations of such variations include the schools' locations and operational boundaries, and the users' environmental awareness, etc.

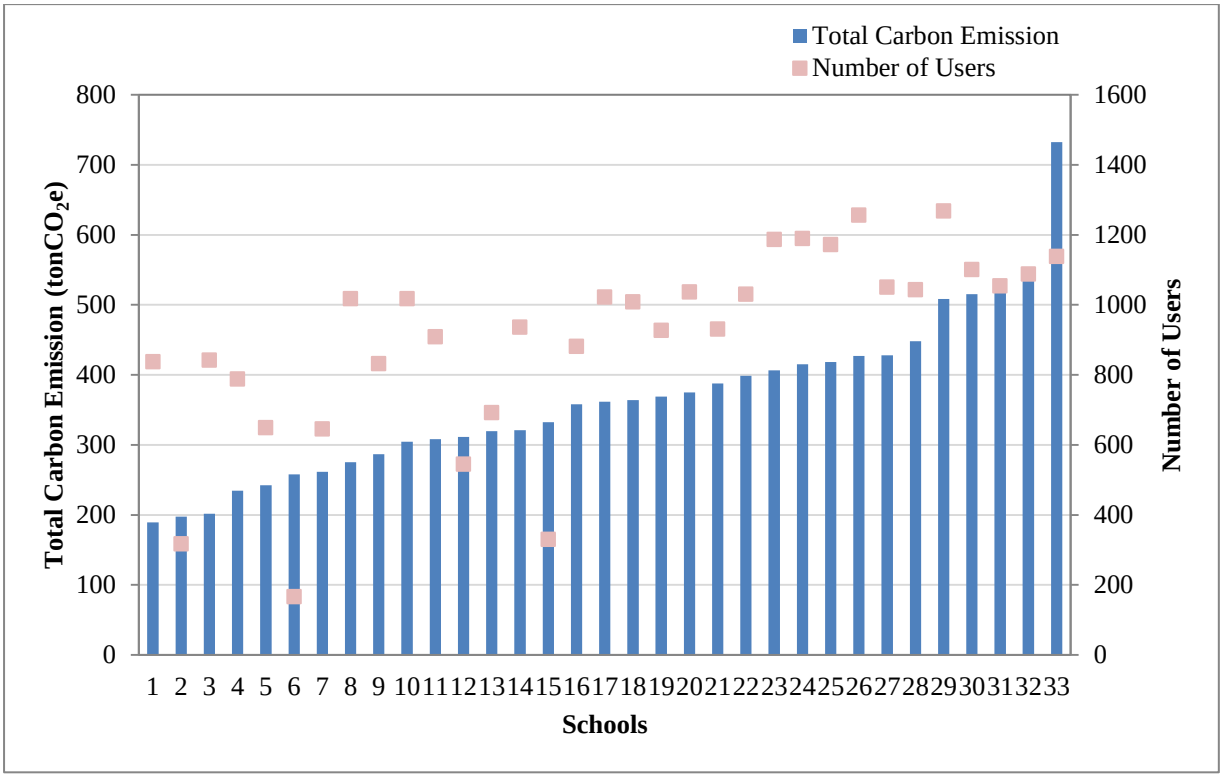


**Figure 4** Total Carbon Emission of Schools in Relation to Number of Users

3.2.3 For a better understanding of the schools' carbon performance, **Figure 5** shows the schools' carbon emission per person. The highest carbon emission per person is 1553.81 $kgCO_2e$ and the lowest is 226.28 $kgCO_2e$.

3.2.4 The average carbon emission per person of the 33 schools is 447.71 $kgCO_2e$; most (24, or 72.73%) schools recorded a below-average carbon emission per person.

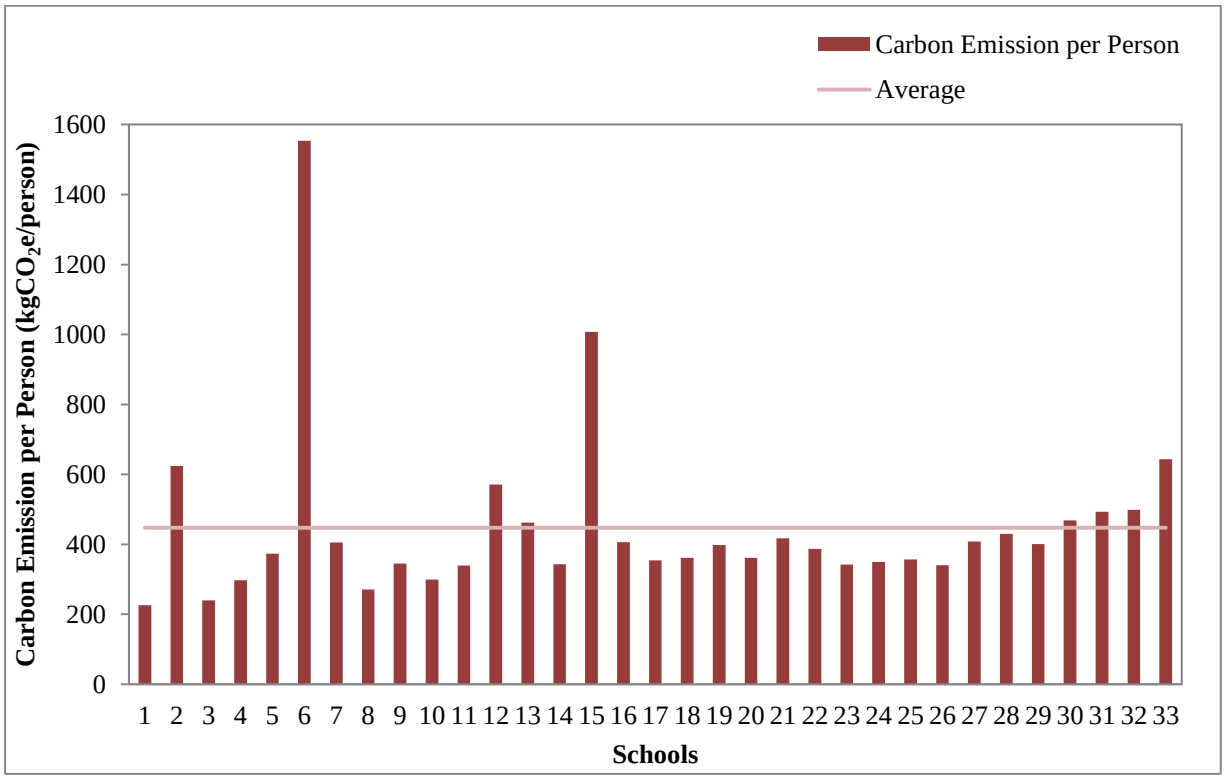


**Figure 5** Carbon Emission Per Person of Schools

3.2.5 **Figure 6** illustrates individual schools' total carbon emission, number of users and carbon emission per person. It is to be noted that, although two schools recorded exceptionally high carbon emission per person (over 1000 $kgCO_2e$), their total carbon emissions are low. The reason for their high carbon emission per person is that the number of users of these two schools is small.

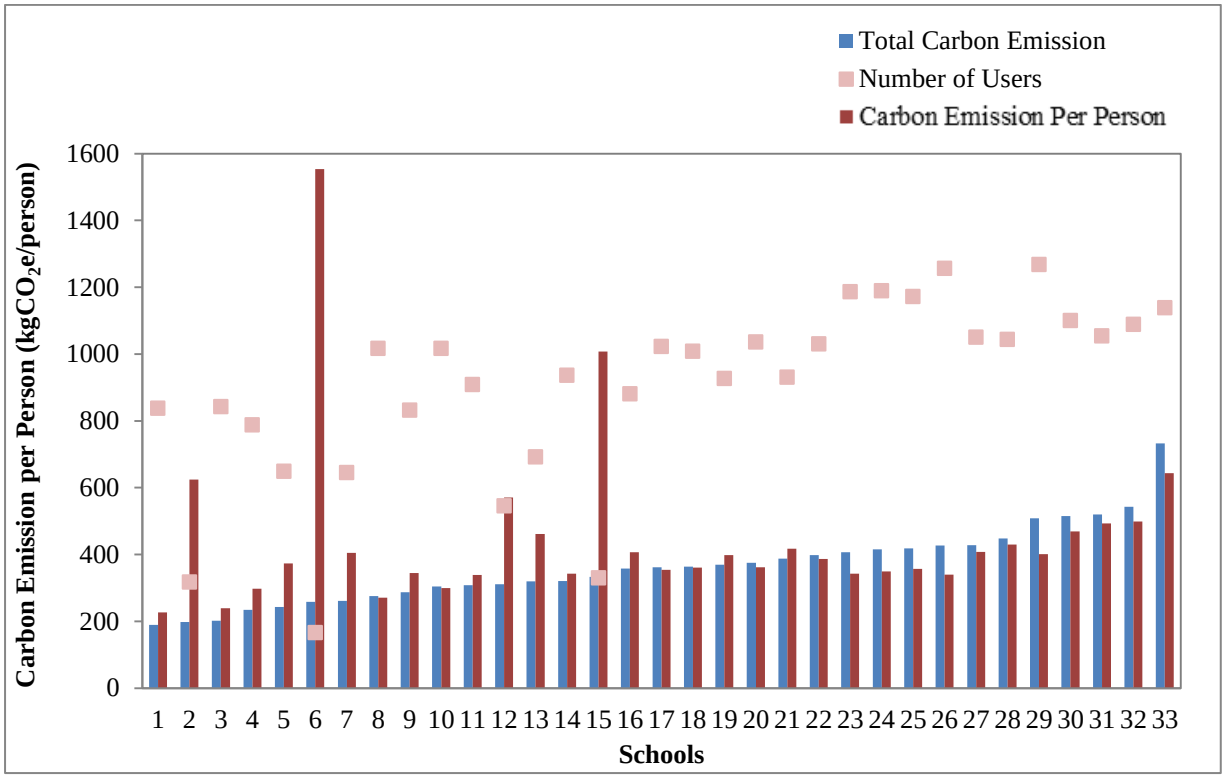


**Figure 6** Total Carbon Emission of Schools in Relation to Number of Users and Carbon Emission Per Person

3.2.6 **Figure 7** categorizes the schools' carbon emission per person into "Low" (below the 25th percentile), "Medium" (between the 25th and 75th percentiles) and "High" (above the 75th percentile) levels.

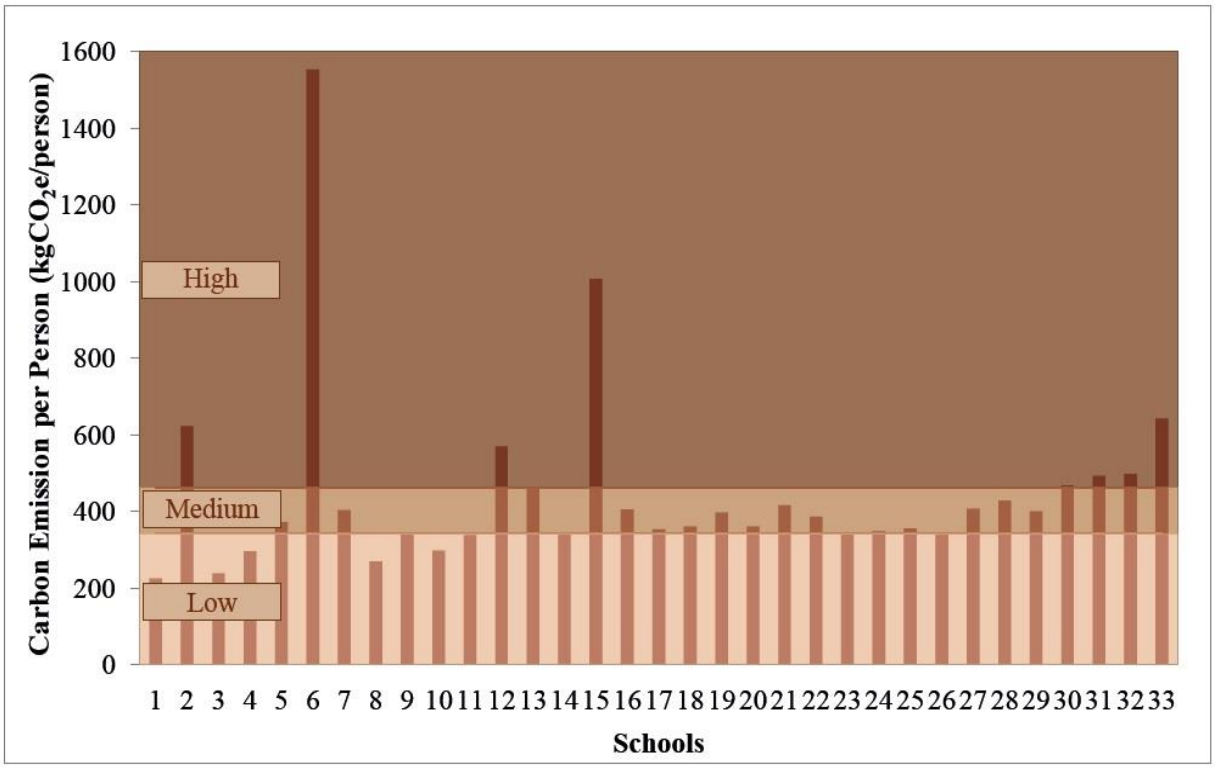


**Figure 7** Carbon Emission Per Person Categorized into Low, Medium and High Levels

3.2.7 **Figure 8** shows the distribution of schools according to the carbon-emission-per-person level categorized into 100-kg$CO_2$e intervals. Most schools (13, or 39.39%) are in the range of 350–450 kg$CO_2$e per person. Two schools outperformed other schools with lower carbon emission per person, i.e. below 250 kg$CO_2$e per person, while there is room for improvement for those nine schools with higher carbon emission per person, i.e. over 450 kg$CO_2$e per person.

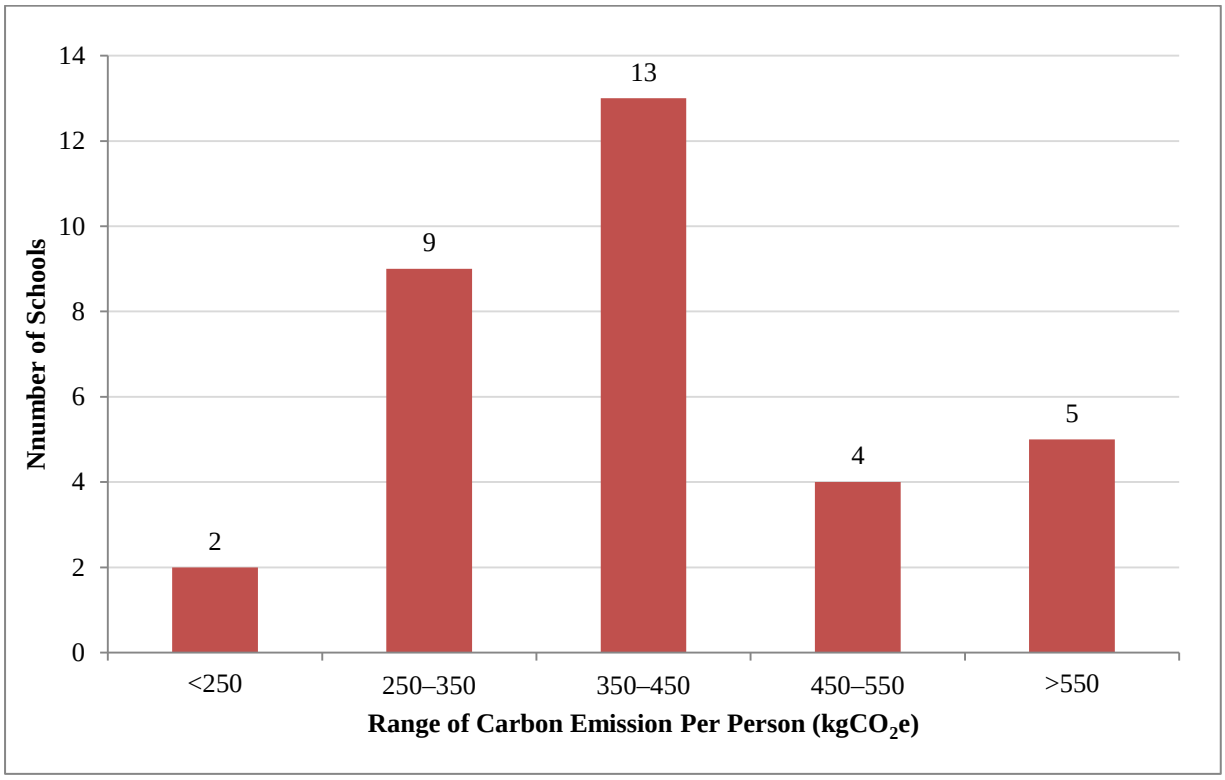


**Figure 8** Distribution of Schools by Carbon Emission Per Person

## 3.3 Carbon Emission Per Square Metre

3.3.1 **Figure 9** shows the schools' total carbon emission in relation to school site area[3]. A mild positive correlation between the schools' total carbon emission and the school site area is observed. Some schools, despite their relatively large physical size, performed very well in maintaining a low-carbon operation.

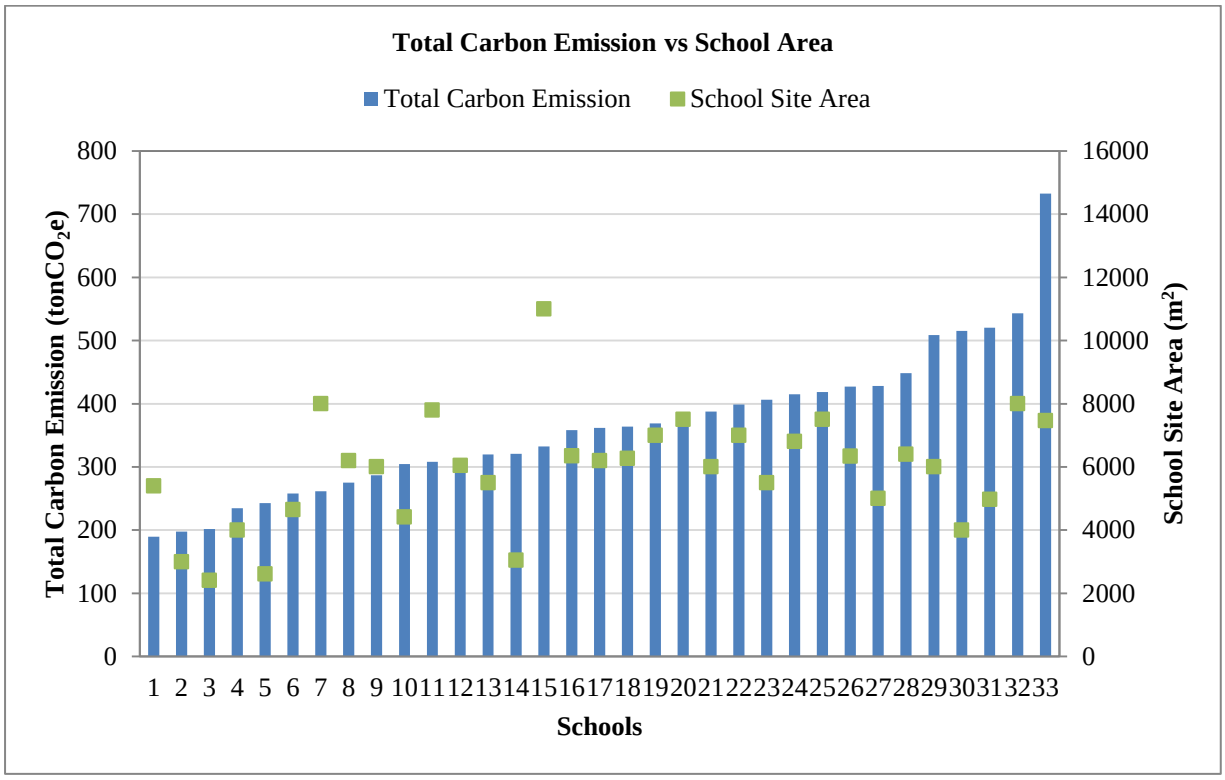


**Figure 9** Total Carbon Emission of Schools in Relation to School Site Area

[3] For the purpose of this carbon audit exercise, "school area" refers to the site area（佔地面積）of a school, i.e. all land held within the school boundary, which is consistently available information for all schools participating in the exercise. Data of school site area are obtained from *Primary School Profiles 2012 and 2013* (http://www.chsc.hk/psp2013/eng/index.php) and *Secondary School Profiles 2012 and 2013* (http://www.chsc.hk/ssp2013/eng/index.php).

3.3.2 **Figure 10** illustrates individual schools' total carbon emission, number of users and school site area. While positive correlations are found between total carbon emission and number of users, as well as between total carbon emission and school site area, the impact of number of users[4] on the schools' total carbon mission is greater than that of school site area[5].

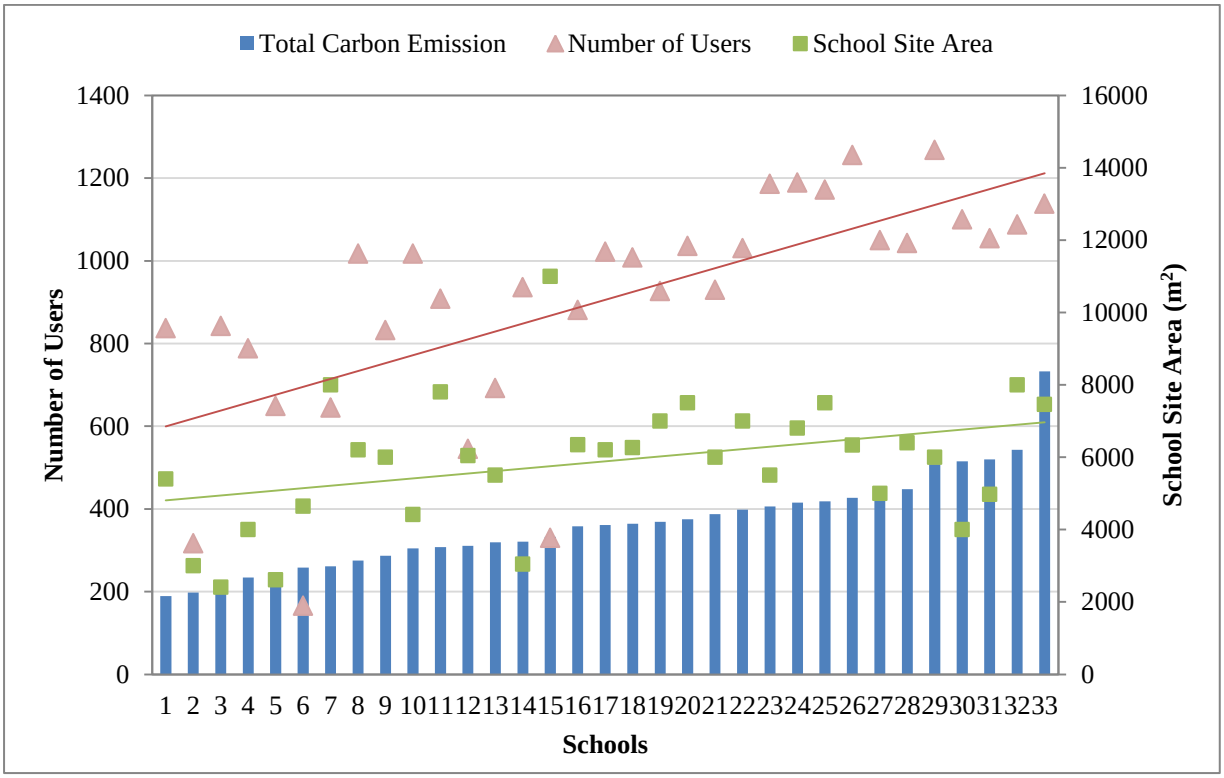


**Figure 10** Total Carbon Emission in Relation to Number of Users and School Site Area

[4] The correlation coefficient between total carbon emission and number of users is 0.65.
[5] The correlation coefficient between total carbon emission and school site area is 0.35.

3.3.3 **Figure 11** shows, for a more comprehensive understanding of the schools' carbon performance, the schools' carbon emission per square metre. The highest carbon emission per square metre is 128.86 $kgCO_2e$ and the lowest is 30.24 $kgCO_2e$.

3.3.4 The average carbon emission per square metre of the 33 schools is 67.05 $kgCO_2e$, and the median is 61.05 $kgCO_2e$, showing that the data are evenly distributed. Nineteen of the 33 schools (57.58%) recorded a below-average carbon emission per square metre.

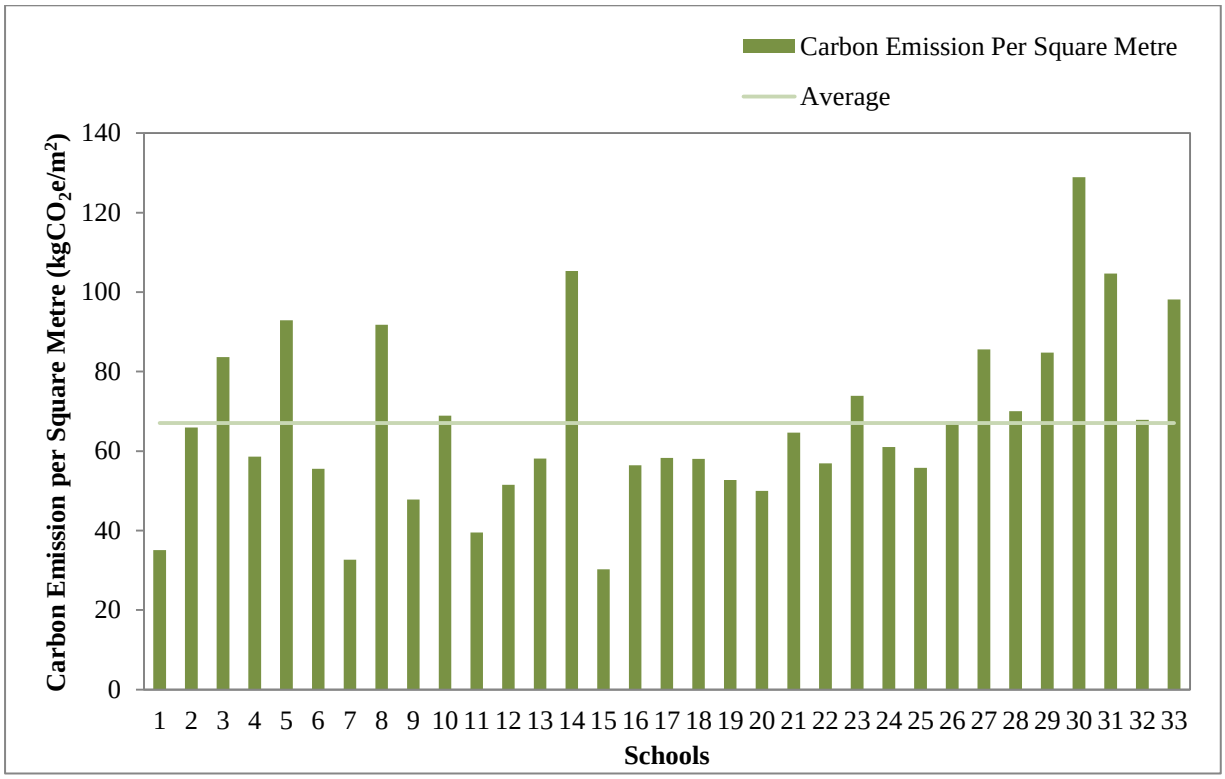


**Figure 11** Carbon Emission Per Square Metre of Schools

3.3.5 **Figure 12** categorizes the schools' carbon emission per square metre into "Low" (below the 25th percentile), "Medium" (between the 25th and 75th percentiles) and "High" (above the 75th percentile) levels.

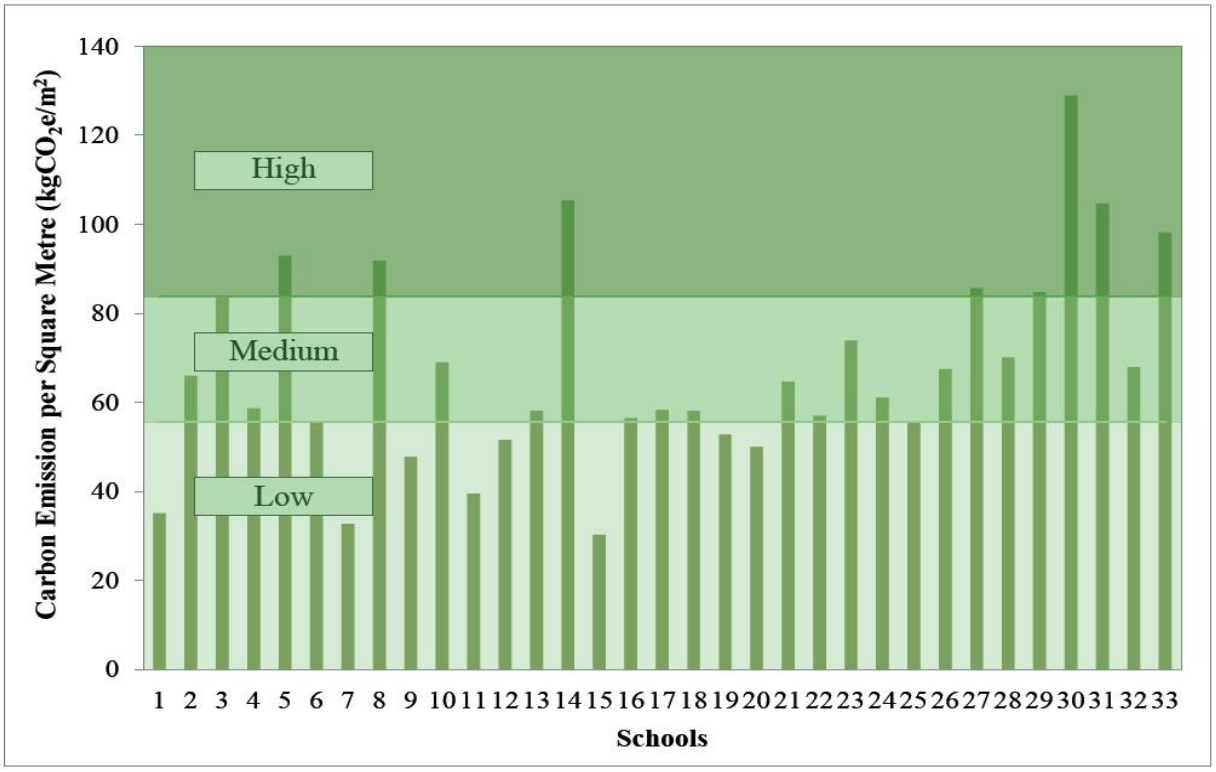


**Figure 12** Carbon Emission Per Square Metre Categorized into Low, Medium and High Levels

3.3.6 **Figure 13** shows the distribution of schools according to the carbon-emission-per-square-metre level categorized into 20-kg$CO_2$e/$m^2$ intervals. Most schools (12, or 36.36%) emitted 40–60 kg$CO_2$e per square metre. Seventeen schools' (52%) carbon-emission-per-square-metre level is on the high side, at more than 60 kg$CO_2$e per square metre.

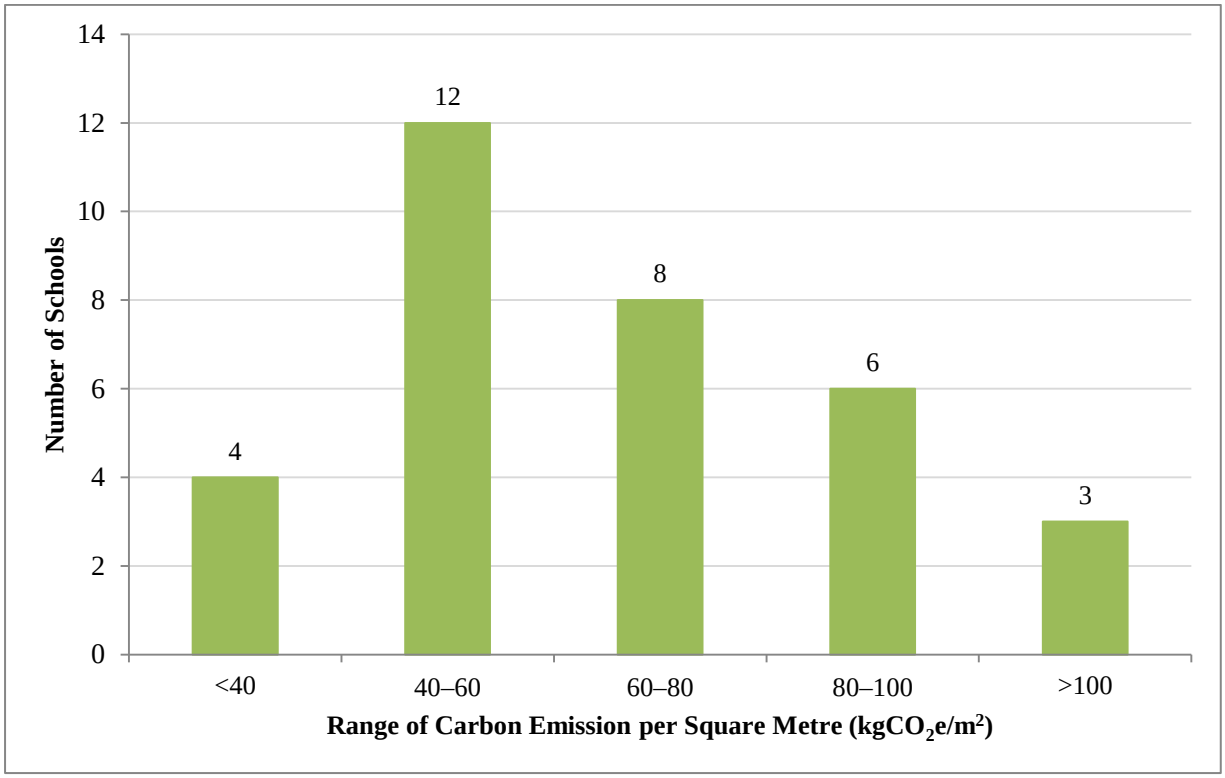


**Figure 13** Distribution of Schools by Carbon Emission Per Square Metre

## 3.4 Carbon Emission by Scope

3.4.1 As noted in 2.1.2 above, the total carbon emission of a school is categorized into three scopes according to its operational boundary:

- Scope 1: Direct Emissions and Removals,
- Scope 2: Energy Indirect Emissions, and
- Scope 3: Other Indirect Emissions.

3.4.2 **Figure 14** shows that, for every school, the largest source of carbon emission is in Scope 2, which accounts for more than half (65.36%–88.42%) of the total carbon emission. Thus, to achieve significant reduction in their carbon footprint, schools are strongly advised to develop plans for cutting down carbon emission in Scope 2.

3.4.3 Again for most schools (28, or 84.85%), the second largest source of carbon emission is in Scope 3, which accounts for 1.63%–27.23% of the total carbon emission. Schools should, to achieve further reduction in their carbon footprint, also work to reduce carbon emission in Scope 3.

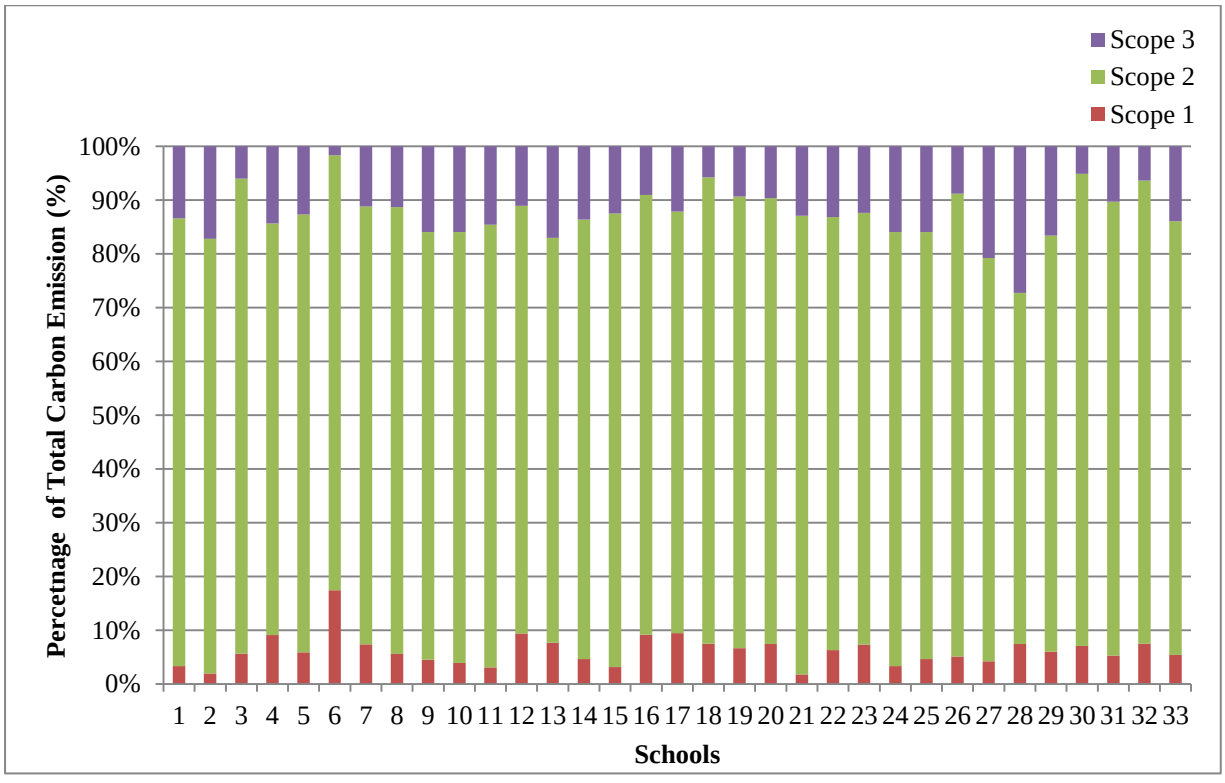


**Figure 14** Distribution of Total Carbon Emission by Scope

3.4.4 **Table 3** shows the extent to which the values of carbon emission are dispersed in Scope 1, Scope 2 and Scope 3. The ranges (the differences between the highest and the lowest values) are considerably large for all three scopes, with the largest range found in Scope 2. Statistically, it means that there is most room for improvement in Scope 2.

| | **Scope 1** | **Scope 2** | **Scope 3** |
|---|---|---|---|
| Highest Carbon Emission (tonnes of $CO_2e$) | 44.90 | 590.84 | 122.05 |
| Lowest Carbon Emission (tonnes of $CO_2e$) | 3.88 | 157.75 | 4.21 |
| Range[6] | 41.03 | 433.09 | 117.84 |
| Inter-quartile Range[7] | 16.82 | 103.06 | 21.20 |
| Standard Deviation[8] | 10.76 | 95.68 | 24.64 |

**Table 3** Dispersion of Carbon Emission from Each Scope

[6] Range refers to the difference between the highest and the lowest values in a set of data. A smaller range indicates a smaller difference.

[7] The inter-quartile range measures how the central 50% of values within the dataset are dispersed. It provides a clearer picture of dispersion of the overall dataset by removing the extreme values at both ends. The higher the inter-quartile range is, the more dispersed the dataset is.

[8] Standard deviation measures the spread of a set of data. A high standard deviation indicates that the data values are very different from each other. A low standard deviation indicates that the data values tend to be very similar.

## 3.5 Primary Schools vs Secondary Schools

3.5.1 As shown in **Figure 15**, the average emission of primary schools is lower than that of secondary schools in all aspects, including total carbon emission, emission per person and emission per square metre.

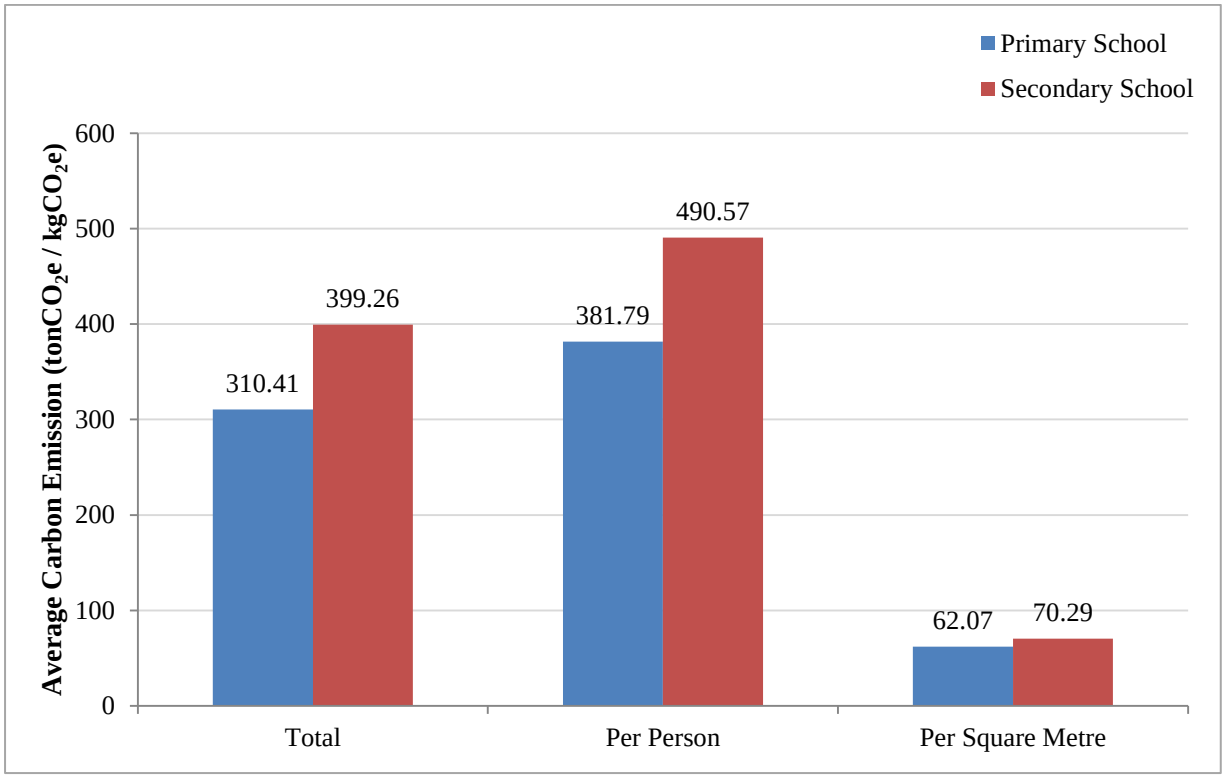


**Figure 15** Average Carbon Emission of Primary and Secondary Schools

3.5.2 **Figure 16** compares the average carbon emission of primary and secondary schools in the three scopes. Primary schools' emissions in all scopes are lower.

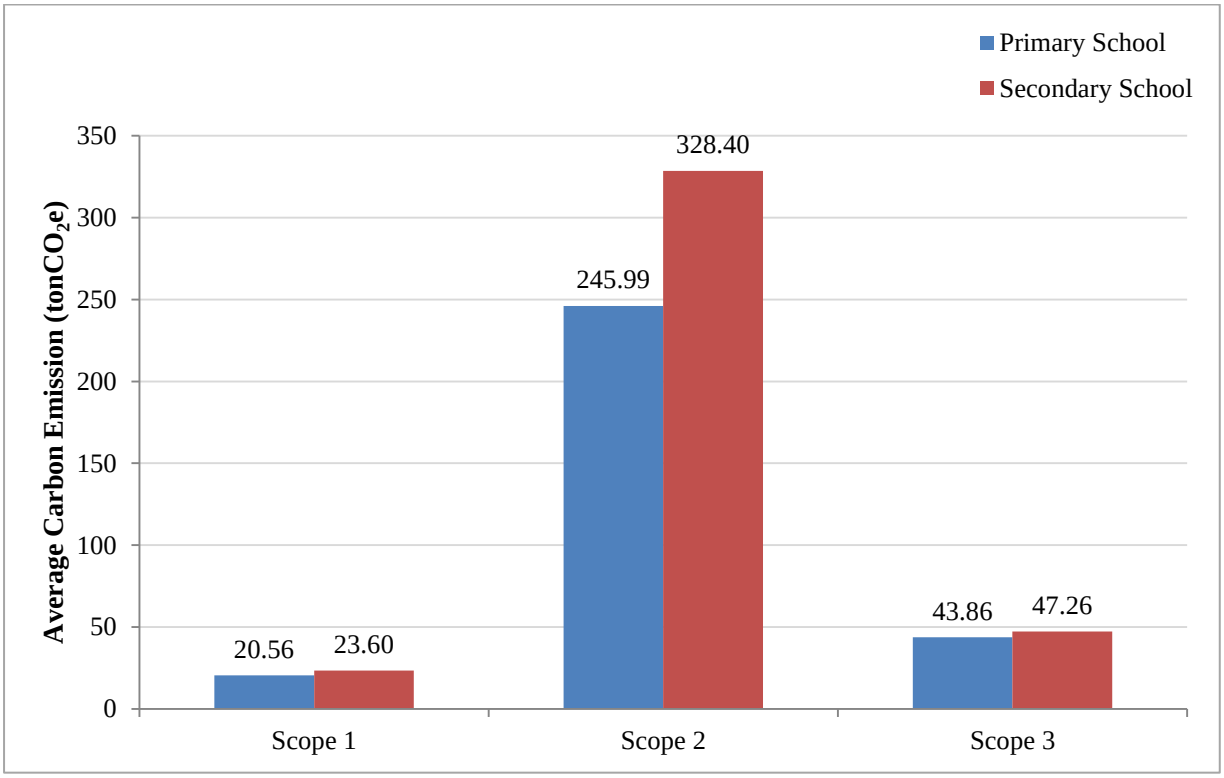


**Figure 16** Average Carbon Emission of Primary and Secondary Schools by Scope

3.5.3 In general, our findings show that primary schools emitted less GHGs than secondary schools did. During the carbon audit exercise, we made the following observations, which might offer partial explanation for the relative performance of the schools:

(a) Primary schools planted more trees than secondary schools. Therefore, primary schools were more able to reduce carbon emission in Scope 1.

(b) More primary schools adopted environmental policies for the operation of air-conditioning system, a major source of carbon emission in Scope 2. Another relevant measure adopted by more primary schools than secondary schools was the use of energy-efficient T5 fluorescent tubes. Both measures contribute to the reduction of carbon emission in Scope 2.

(c) More primary schools had paper use policy in place. Secondary schools in general, and understandably so, had more school trips. These two factors determine the level of Scope 3 emission and, therefore, lower carbon emission is found in primary schools.

## 3.6 Benchmarks against EMSD Energy Consumption Indicator

3.6.1 **Table 4** is a comparison of the carbon audit results against the energy consumption indicator published by EMSD in 2010[9]. It reveals that in general, secondary schools use more energy and emit more GHGs than primary schools.

| | Secondary Schools | Primary Schools |
|---|---|---|
| Annual GHG Emission per School Site Area (2011/12) | 35.1 | 30.5 |
| EMSD Annual Energy Consumption per Gross Floor Area | 214[10] | 186[11] |

**Table 4** Benchmarks against EMSD Energy Consumption Indicator

3.6.2 It should be noted that the EMSD annual energy consumption per area is normalized against the school gross floor area (GFA), while the average energy consumption and emission figures in this carbon audit exercise is normalized against the school site area[12]. Although direct comparison is not applicable, in terms of carbon emission per square metre for the secondary schools and primary schools, our findings are in line with the EMSD indicator.

## 3.7 Conclusion

3.7.1 This section summarizes the findings of the carbon audit exercise, including the emission figures in terms of total carbon emission, emission per person and emission per square metre, and distribution of emission sources at schools. To provide a benchmark for the schools to evaluate their performance against their peers, the school emission levels are categorized into three groups, namely, "Low", "Medium" and "High".

3.7.2 The carbon audit results correspond to the EMSD energy consumption indicator, suggesting that primary schools generally emit less GHGs than secondary schools.

3.7.3 The carbon audit results reveal that the majority of carbon emissions is from Scope 2, Energy Indirect Emissions. Between 65.36% and 88.42% of emissions comes from electricity purchased.

3.7.4 Between 1.79% and 17.41% of emissions from schools is in Scope 1, Direct Emissions and Removals. The most notable source is direct leakage of refrigerants.

3.7.5 Schools' emissions in Scope 3, Other Indirect Emissions, vary largely from 1.63% to 27.23%, because of the significant differences in the numbers of study tours and business trips.

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9 Energy Consumption Indicator from Energy Efficiency Office of EMSD, 2010, http://ecib.emsd.gov.hk/en/index02.htm

10 Commercial – Energy Consumption Indicator, "B19: Secondary School" in Principal Group 4 – Educational Services, http://ecib.emsd.gov.hk/en/indicator_cmc.htm

11 Commercial – Energy Consumption Indicator, "B20: Primary School" in Principal Group 4 – Educational Services, http://ecib.emsd.gov.hk/en/indicator_cmc.htm

12 For the purpose of this carbon audit exercise, school site area（佔地面積), i.e. all land held within the school boundary, which is consistently available information for all participating schools, is used.

3.7.6 Based on the findings of the carbon audit exercise, the five areas for improvement that might help schools achieve major carbon reduction include:

(a) lighting system,

(b) air-conditioning system,

(c) other electrical appliances,

(d) paper usage, and

(e) water usage.

More details can be found in Section 5 of this report and the schools' individual carbon audit reports.

## Section 4 Carbon Footprint Summary of Go Green NGOs

### 4.1 Carbon Inventory

4.1.1 Appendix E is a carbon inventory of the NGOs in 2011/12 (the baseline year of the inventory, which is to be updated when a further round of carbon audit completes)[13].

4.1.2 It is to be noted that benchmarks and comparison that are applicable to schools cannot be directly adopted for NGOs because of their distinct service nature and organization size. Among the eight NGOs, there are offices, clinics, youth centres, community service centres and residential care homes, each with its own service nature and operation mode. For example, the offices open on weekdays only, while the residential care homes operate 24 hours all year round. Clients of youth centres are teenagers, while clients of residential care homes are those who need rehabilitation or medical services.

4.1.3 In addition to the vastly different service nature and organization size, another reason that direct comparison and benchmarking among the eight NGOs is not recommended is the small sample size.

4.1.4 Despite the aforementioned constraints, the carbon inventory in Appendix E shall form an emission baseline for the eight NGOs for future benchmarking.

4.1.5 To help individual NGOs better understand their carbon performance, the following sub-section discusses their carbon emission by scope.

### 4.2 Carbon Emission by Scope

4.2.1 As noted in 2.1.2 above, the total carbon emission of an NGO is categorized into three scopes according to its operational boundary:

- Scope 1: Direct Emissions and Removals,
- Scope 2: Energy Indirect Emissions, and
- Scope 3: Other Indirect Emissions.

[13] Appendix E is compiled on an anonymous basis, but an NGO may refer to its own carbon audit report to identify itself from the inventory.

4.2.2 **Figure 17** shows the total carbon emission of the eight NGOs by scope.

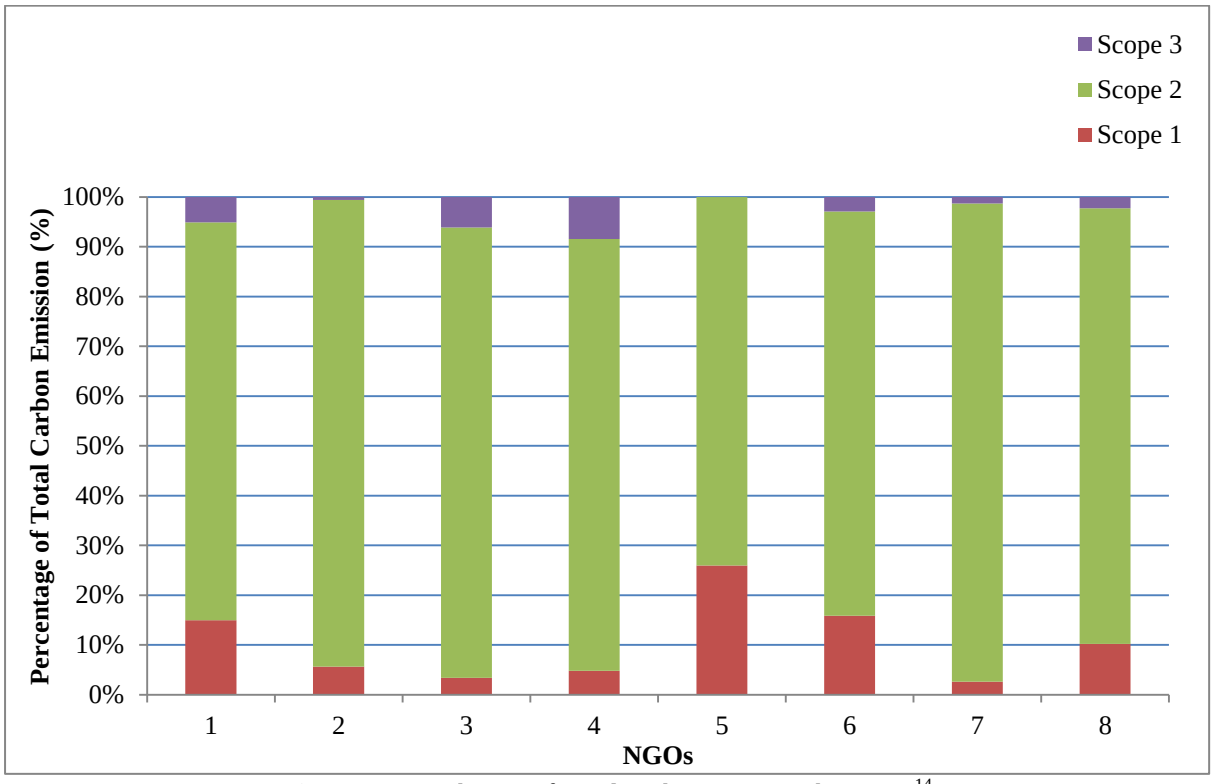


**Figure 17** Distribution of Total Carbon Emission by Scope[14]

4.2.3 The largest source of carbon emission for the NGOs is Scope 2, which accounts for most (74.06%–96.13%) of the total carbon emission. Thus, to achieve significant reduction in their carbon footprint, NGOs are strongly advised to develop plans for cutting down carbon emission in Scope 2. Particular attention should be paid to:

(a) Air-conditioning and lighting systems: The carbon audit results show that more than half (54.28%–82.78%) of Scope 2 carbon emission comes from electricity purchased for these systems.

(b) Other electrical appliances: The carbon audit results show they account for a relatively large proportion (36.46%–45.72%) of Scope 2 carbon emission. It is applicable to those NGOs that provide medical services or accommodation, as a major portion of their electricity consumption comes from medical instruments and home electrical appliances.

4.2.4 For most NGOs (6, or 75%), Scope 1 is the second largest source of carbon emission, which accounts for 2.60%–25.94% of the total carbon emission. The range is relatively broad because of the differences in service nature and the needs of clients. Vehicles used by NGOs serving elderly and disabled emitted greenhouse gases. Therefore, their Scope 1 carbon emission is higher. These NGOs should, to achieve further reduction in their carbon footprint, work to reduce carbon emission in Scope 1.

[14] NGO #5 did not provide data for Scope 3 emission.

4.2.5 It is worth mentioning that, while the NGOs' Scope 3 carbon emission, in accordance with the available data, does not appear to be of major concern, NGOs are highly recommended to maintain a complete and detailed record of operations in relation to Scope 3 emission sources, such as paper and water usage. In the long run, such information will be helpful to the organizations to develop and select the most relevant carbon reduction strategies.

## 4.3 Other Observations and Comparison

4.3.1 In addition to the analysis of data collected before and during carbon audits, the Go Green Team also gathered qualitative data with a view to better understanding the NGOs' carbon performance. The following is a list of observations that may underpin the NGOs' development of carbon reduction strategies:

(a) Optimum illumination level was observed in most of the eight NGOs; no excessive lighting was found.

(b) Most NGOs keep the good practice to turn off unnecessary lighting.

(c) The more energy-consuming lighting systems (T8 fluorescent tubes) are still in use in half of the NGOs.

(d) All NGOs use the more energy-consuming fluorescent-tube exit signs, which are recommended to be replaced by LED exit signs that are far more energy-efficient.

(e) Most NGOs do not have specific guidelines on the use of air-conditioners (e.g. to maintain the room temperature at 25.5℃ or above).

(f) Most NGOs use air-conditioners of older models that do not carry the Grade 1 Energy Label.

(g) Air-conditioners with an ozone-depleting substance refrigerant (R22) are used in most NGOs.

(h) Most NGOs do not have specific guidelines or policy on paper recycling.

## 4.4 Conclusion

4.4.1 This section summarizes the findings of the carbon audit exercise, in terms of the NGOs' carbon emission by scope, and also observations of the Go Green Team.

4.4.2 The carbon audit results reveal that the majority of carbon emissions (up to 82.78%) is from Scope 2, Energy Indirect Emissions. The major source is the air-conditioning and lighting systems.

4.4.3 As noted above, many NGOs have some good practices in terms of keeping an optimal illumination level of lighting and turning off unnecessary lighting. However, there is much room for improvement in other aspects, including the types of lighting

used (exit signs included), the use of air-conditioning system in a more environmentally friendly manner, and paper cycling.

4.4.4 NGOs are, overall, recommended to focus their efforts on reducing carbon emissions in Scope 2, by cutting down energy consumption in the air-conditioning and lighting systems as much as possible.

## Section 5 Carbon Reduction Recommendation

5.1 Identification and analysis of potential carbon reduction measures are conducted and recommended in the individualized carbon audit reports, based on the information collected from the schools and NGOs and during site visits, and the findings of the carbon audit exercise.

5.2 The recommended carbon reduction measures mainly focus on five aspects, i.e. lighting system, air-conditioning system, other electrical appliances, paper usage and water usage. **Table 5** summarizes the measures on the five aspects recommended to the schools and NGOs.

| Carbon Reduction Measures Recommended | Applicable to Situation Where… | Estimated Reduction upon Successful Implementation |
|---|---|---|
| ***A. Lighting System*** | | |
| A1. To use T5 fluorescent tubes instead of T8 or T12 ones | Energy-consuming T8 or T12 fluorescent tubes are being used | 30–50% |
| A2. To use LED MR16 lamps instead of halogen ones | Energy-consuming MR16 halogen lamps are being used | 70–80% |
| A3. To use compact fluorescent tubes instead of incandescent lamps | Energy-consuming incandescent lamps are being used | 70–80% |
| A4. To use LED exit signs instead of fluorescent-tube ones | Energy-consuming fluorescent-tube exit signs are being used | 70–80% |
| A5. To remove excessive lighting | There is excessive lighting or over-illumination | Depending on situation |
| A6. To switch off unnecessary lighting | The lights remain on when not in use or during daytime | Depending on situation |
| A7. To install motion sensors | The lights remain on even when nobody is present in the room | Depending on situation |
| A8. To install separate circuits | All lights in the room are being controlled by a single switch | Depending on situation |
| ***B. Air-conditioning System*** | | |
| B1. To use new-model air-conditioners with Grade 1 Energy Label | Old-model air-conditioners with no energy labels are being used | 15–29% |
| B2. To use air-conditioners with non-ODS refrigerant | Air-conditioners with ODS refrigerant are being used | Depending on situation |
| B3. To clean the air-conditioner filters regularly | The efficiency of the air-conditioners is affected by dirty filters | Depending on situation |
| B4. To install air-curtain above the entrance, to stop cool air escape | Cool air escapes and warm air moves in to the room during summer | Depending on situation |
| B5. To apply solar window film | The windows face west or southwest | ~3% |
| B6. To apply heat shield coating on the roof | Heat management on the roof is needed in order to maintain a comfortable temperature in the top-floor rooms | ~3% |

| Carbon Reduction Measures Recommended | Applicable to Situation Where… | Estimated Reduction upon Successful Implementation |
|---|---|---|
| B7. To set the air-conditioner temperature at 25.5°C | The air-conditioner temperature is set at lower than 25.5°C | ~3% per degree |
| B8. To use rotary fans for better ventilation, so as to increase the efficiency of the air-conditioners | Air-conditioners are the only appliances used for cooling | Depending on situation |
| B9. To rely on natural ventilation by opening the windows | The temperature is lower than 25.5°C (or a temperature below which air-conditioning is not allowed in accordance with the relevant policies or rules) | Depending on situation |
| B10. To remind the users of the best practices in using air-conditioners, by posting reminders near the switches of the air-conditioners | The users are not familiar with the relevant policies and/or the best practices for the use of air-conditioners | Depending on situation |
| B11. To assist the users to follow policies or rules for the use of air-conditioning, by placing thermometers near the switches of the air-conditioners | There are policies or rules specifying the temperature (e.g. 26°C) at or above which air-conditioning is allowed | Depending on situation |
| ***C. Other Electrical Appliances*** | | |
| C1. To use LCD monitors instead of CRT ones | Energy-consuming CRT monitors are being used | ~40% |
| C2. To use LED televisions instead of CRT ones | Energy-consuming CRT televisions are being used | ~30% |
| C3. To use refrigerators with Grade 1 Energy Label | Old-model refrigerators with no energy labels are being used | 35–49% |
| C4. To use refrigerators with non-ODS refrigerant | Refrigerators with ODS refrigerant are being used | Depending on situation |
| C5. To install timers | Electrical appliances remain on after working hours | Depending on situation |
| C6. To use energy-saving plugs | Electrical appliances remain on after working hours | Depending on situation |
| C7. To switch off the elevators after working hours | The elevators are in operation during non-working hours | Depending on situation |
| ***D. Paper Usage*** | | |
| D1. To send used paper for recycling | The consumption of paper is high | Depending on situation |
| D2. To reuse used paper | The consumption of paper is high | Depending on situation |
| D3. To adopt double-sided printing | The consumption of paper is high | Depending on situation |
| D4. To use email, instead of memo in hardcopy, to circulate information | The consumption of paper is high | Depending on situation |
| D5. To upload handouts and teaching materials on the web, instead of distributing printouts | The consumption of paper is high | Depending on situation |
| ***E. Water Usage*** | | |
| E1. To use infrared-sensor water taps instead of conventional ones | The consumption of water is high | Depending on situation |
| E2. To adjust the water volume and running time of the taps | The consumption of water is high | Depending on situation |

| Carbon Reduction Measures Recommended | Applicable to Situation Where… | Estimated Reduction upon Successful Implementation |
|---|---|---|
| E3. To install tap aerators or other water-saving devices | The consumption of water is high | 30–50% |
| E4. To use dual-flash buttons instead of press-type or handle-type water cisterns | The consumption of flushing water is high | Depending on situation |

**Table 5** Summary of Carbon Reduction Measures Recommended

5.3 Both schools and NGOs are strongly advised to develop plans for cutting down carbon emission in Scope 2, mainly from lighting and air-conditioning systems, to achieve significant reduction in their carbon footprint.

5.4 Schools are recommended to also work to reduce carbon emission in Scope 3, mainly from paper usage and water usage, to achieve further reduction in their carbon footprint.

5.5 Secondary schools are encouraged to learn from primary schools in terms of formulating environmental policies to regulate behaviour on energy use and paper use, as well as greening the school environment by planting and nurturing trees and other flora.

5.6 NGOs are recommended to, due to the differences in service nature and organization size, devise their own carbon reduction plans that suit their situations, needs and resources, making reference to their carbon audit reports presented by the Go Green Team.

## Section 6 Conclusion

6.1 This benchmarking report summarizes the findings of the carbon audit exercise, including the emission figures in terms of total carbon emission, emission per person, emission per square metre, and the emission sources distribution. Based on these findings, carbon reduction measures are recommended for the schools and NGOs.

6.2 Benchmarks are developed for the schools to evaluate their performance against their peers, including:

(a) average emission in terms of total carbon emission, emission per person, and emission per square metre,

(b) categorization of three groups "Low", "Medium" and "High", and

(c) distribution of the three groups "Low", "Medium" and "High".

6.3 The schools' carbon emissions are also benchmarked against an established standard, namely, the energy consumption indicator published by EMSD in 2010. Our carbon audit results suggest that primary schools consume less energy than secondary schools, which are in line with the EMSD indicator. In connection with this finding, the Go Green Team endeavours to provide more platforms that encourage exchanges between primary and secondary schools and sharing of good practices.

6.4 Direct comparison among NGOs is not applicable owing to the vast differences in organization size and service nature. Instead of benchmarks, a summary on NGOs' carbon emission performance is presented in this report.

6.5 The carbon audit results reveal that major portion of carbon emissions, for both schools (65.36%–88.42%) and NGOs (74.06%–96.13%), are from Scope 2, Energy Indirect Emissions. Scope 2 carbon emissions are mainly from the electricity purchased for lighting and air-conditioning systems.

6.6 In accordance with the findings of the carbon audit exercise, the Go Green Team recommends carbon reduction measures in five aspects, i.e. lighting system, air-conditioning system, other electrical appliances, paper usage and water usage. Schools and NGOs are advised to refer to their carbon audit reports for various tailor-made recommendations on carbon reduction measures.

(November 2014)

Appendix A

**Go Green Community – Jockey Club Carbon Reduction Partnership Scheme (Pilot Phase)**

List of Schools (In Alphabetical Order)

| School Name | Location |
|---|---|
| A.D. & F.D.P.O.H. Ltd. Leung Sing Tak School | Phase 3, Long Ping Estate, Yuen Long, N.T. |
| Alliance Primary School, Tai Hang Tung | 13 & 23 Tong Yam Street, Tai Hang Tung, Kowloon |
| Baptist (Sha Tin Wai) Lui Ming Choi Primary School | 8 Yuen Chau Kok Road, Sha Tin Wai, Shatin, N.T. |
| Buddhist Wing Yan School | No. 6 Fung Yau Street South, Yuen Long, N.T. |
| C.C.C. Chuen Yuen Second Primary School | No. 3 Sheung Kok Street, Tai Wo Hau, Kwai Chung, N.T. |
| C.C.C. Kei Wai Primary School (Ma Wan) | 12 Pak Lam Rd., Park Island, Ma Wan, N.T. |
| Cheung Chau Government Secondary School | 5B School Road, Cheung Chau, N.T. |
| China Holiness Church Living Spirit College | 1 Tung Leung Lane, Tai Po, N.T. |
| Chiu Yang Por Yen Primary School | 55 Tin Hua Road, Tin Shui Wai, Yuen Long, N.T. |
| Choi Hung Estate Catholic Secondary School | 1 Tse Wai Avenue, Choi Hung Estate, Kowloon |
| Concordia Lutheran School | 12 Tai Hang Tung Road, Shek Kip Mei, Kowloon |
| Confucius Hall Secondary School | 77 Caroline Hill Road, Causeway Bay, Hong Kong |
| Haven of Hope Sunnyside School | 301 Anderson Road, Tseung Kwan O, N.T. |
| HHCKLA Buddhist Wisdom Primary School | 6 Ching Shing Road, Sheung Shui, N.T. |
| HKSYCIA Wong Tai Shan Memorial College | 250 Nam Cheong Street, Sham Shui Po, Kowloon |
| Hong Kong Teachers' Association Lee Heng Kwei Secondary School | Wan Tau Tong Estate, Tai Po, N.T. |
| Kau Yan College | Fu Shin Estate, Tai Po, N.T. |
| Kowloon Tong School (Secondary Section) | 10 Surrey Lane, Kowloon Tong, Kowloon |
| Lingnan University Alumni Association (HK) Primary School | 33 Pak Tin Street, Shek Kip Mei, Kowloon |
| Methodist College | 50 Gascoigne Road, Yaumatei, Kowloon |

| School Name | Location |
|---|---|
| Ng Yuk Secondary School | Sun Chui Estate,<br>Tai Wai, Sha Tin, N.T. |
| Po Chiu Catholic Secondary School | 1 Po Chiu Road, Yau Tong, Kowloon |
| Shak Chung Shan Memorial Catholic Primary School | 39 Wing Shun Street, Riviera Garden, Tsuen Wan, N.T. |
| SKH Kowloon Bay Kei Lok Primary School | 6 Kai Yan Street, Kowloon Bay, Kowloon |
| SKH St. Simon's Lui Ming Choi Secondary School | 85 Heung Sze Wui Road, Tuen Mun, N.T. |
| Tai Po Old Market Public School (Plover Cove) | No. 7 Plover Cove Road, Tai Po, N.T. |
| Tak Oi Secondary School | 8 Tsz Wan Shan Road, Kowloon |
| The Chinese Foundation Secondary School | 9 Harmony Road, Siu Sai Wan, Hong Kong |
| True Light Girls' College | 54A Waterloo Road, Yau Ma Tei, Kowloon |
| Tsang Pik Shan Secondary School | 12 Hang Kwong Street, Ma On Shan, Shatin, N.T. |
| TWGHs Yau Tze Tin Memorial College | Siu Hong Court, Tuen Mun, N.T. |
| TWGHs Yow Kam Yuen College | Area 14 J, City One, Shatin, N.T. |
| W F Joseph Lee Primary School | 9 Tin Fai Road, Tin Shui Wai, Yuen Long, N.T. |

Appendix B

**Go Green Community – Jockey Club Carbon Reduction Partnership Scheme (Pilot Phase)**

List of Non-governmental Organizations (NGOs) (In Alphabetical Order)

| NGO Name | Location |
|---|---|
| Caritas Jockey Club Integrated Service For Young People – Lei Muk Shue | Wings B & C, G/F, Kin Shue House, Lei Muk Shue Estate, Tsuen Wan, N.T. |
| Haven of Hope Christian Service | 7 Haven of Hope Road, Tseung Kwan O, N.T. |
| Heep Hong Society Cheung Ching Early Education and Training Centre | G/F,110–112 Ching Kwai House, Cheung Ching Estate, Tsing Yi, N.T. |
| Jockey Club Centre for Positive Ageing | 27 A Kung Kok Street, Shatin, N.T. |
| St. James' Settlement Jockey Club Chai Wan Integrated Services Centre | Shopping Square, Hing Wah (II) Estate, Chai Wan, Hong Kong |
| The Neighbourhood Advice-Action Council Harmony Manor | 45A, Kung Kok Shan Road, Shatin, N.T. |
| The Neighbourhood Advice-Action Council Shanghai Fraternity Association Care and Attention Home for the Elderly | 4F–5F, Ko Fai House, Kwun Fai Court, Ho Man Tin, Kowloon |
| United Christian Nethersole Community Health Service Kwong Fuk Community Health Centre | G/F, Kwong Yan House, Kwong Fuk Estate, Tai Po, N.T. |

Appendix C

## Go Green Community – Jockey Club Carbon Reduction Partnership Scheme (Pilot Phase)

List of Emission Factors Applied in the Carbon Audit Exercise

| Scope | Emission/Removal Description | Emission Factor | | | | | Factor Source |
|---|---|---|---|---|---|---|---|
| 1 | Fuel consumption from stationary combustion sources | **Source** | **Fuel Type** | **$CO_2$** | **$CH_4$** | **$N_2O$** | EPD/EMSD[15] |
| | | Bunsen burners | Town gas | 2.549 kg/unit | 0.0446 g/unit | 0.0099 g/unit | |
| | Fuel consumption from mobile combustion sources | **Vehicle Type** | **Fuel Type** | **$CO_2$** | **$CH_4$** | **$N_2O$** | EPD/EMSD |
| | | Passenger car | ULP[16] | 2.360 kg/litre | 0.253 g/litre | 1.105 g/litre | |
| | | Light goods vehicles | ULP | 2.360 kg/litre | 0.203 g/litre | 1.105 g/litre | |
| | | Medium goods vehicle | LPG[17] | 1.679 kg/litre | 0.248 g/litre[18] | 0[8] | |
| | | | DO[19] | 2.614 kg/litre | 0.145 g/litre | 0.072 g/litre | |
| | | Hybrid | ULP | 2.360 kg/litre | 0.253 g/litre | 1.105 g/litre | |
| | | Marine vessel | ULSD[20,21] | 2.614 kg/litre | 0.145 g/litre | 0.072 g/litre | |
| | Intentional or unintentional release from equipment and systems | **Source** | | **Operation Emission (%)** | | | IPCC[22] |
| | | Refrigerant of air-conditioning systems | | 1–10% | | | |
| | Assimilation of $CO_2$ into biomass | **Source** | | **$CO_2$** | | | EPD/EMSD |
| | | Trees | | 23 kg$CO_2$e/tree/year | | | |

[15] *Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong* (2010 Edition), published by the Environmental Protection Department (EPD) and the Electrical and Mechanical Services Department (EMSD)

[16] ULP: unleaded petrol

[17] LPG: liquefied petroleum gas

[18] $CH_4$ and $N_2O$ emission factors for LPG medium goods vehicles are not indicated in the EPD/EMSD *Guidelines*; the emission factors for LPG private vans are used for calculations for the purpose of this exercise.

[19] DO: diesel oil

[20] ULSD: ultra low sulphur diesel

[21] ULSD emission factors are not indicated in the EPD/EMSD *Guidelines*; DO emission factors for heavy goods vehicles are used for calculations for the purpose of this exercise.

[22] *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, published by the Intergovernmental Panel on Climate Change

| Scope | Emission/Removal Description | Emission Factor | Factor Source |
|---|---|---|---|
| 2 | Electricity purchased | CLP Power Hong Kong Limited: 0.59 $kgCO_2e/kWh$ | Power companies |
| | | Hongkong Electric Holdings Limited: 0.79 $kgCO_2e/kWh$ | |
| | Town gas purchased | 0.593 $kgCO_2e$/unit | EPD/EMSD |
| 3 | Paper disposal at landfills | 4.8 $kgCO_2e/kg$ | EPD/EMSD |
| | Electricity used for fresh water processing by the Water Supplies Department (WSD) | 0.41 $kgCO_2e/m^3$ | WSD |
| | Electricity used for sewage processing by the Drainage Services Department (DSD) | Siu Ho Wan Sewage Treatment Works: 0.16 $kgCO_2e/m^3$ | DSD |
| | | Shatin Sewage Treatment Works: 0.27 $kgCO_2e/m^3$ | |
| | | Airplane Domestic (<1.5hr): 0.1648 kgCO2e/pkm[23] | Defra/DECC[24] |
| | | Airplane Short-haul (<3hr) and Medium-haul (3-6.5hr): 0.0923 kgCO2e/pkm | |
| | | Airplane Long-haul (>6.5hr): 0.0814 kgCO2e/pkm | |
| | | Ferry (Hong Kong—Macau) : 12.7 kgCO2e/ptrip[25] | WWF[26] |
| | | High Speed Railway (China): 0.0392 kgCO2e/pkm | UIC[27] |
| | | Coach (China): 0.018 kgCO2e/pkm | Li, et al.[28] |
| | Electricity and fuel used for handling of chemical waste at the Chemical Waste Treatment Centre in Tsing Yi | 0.21 $kgCO_2e/kg$ | HKU/CityU[29] |

[23] pkm: passenger-km, a measure of the total distance travelled by passengers

[24] *2011 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors*, published by the Department for Environment, Food and Rural Affairs (Defra) and the Department of Energy and Climate Change (DECC), UK

[25] ptrip: passenger-trip

[26] WWF Hong Kong Carbon Calculator (Version 2.0), published by WWF Hong Kong

[27] *Carbon Footprint of High Speed Rail*, November 2011, published by International Union of Railways (UIC)

[28] Li Peng, et al., "GHG Emission-based Eco-efficiency Study on Tourism Itinerary Products in Shangri-La, Yunnan Province, China", *Acta Ecologica Sinica*, 28(5), 2008

[29] *Carbon Audit Toolkit for Small and Medium Enterprises in Hong Kong*, published by the University of Hong Kong (HKU) and the City University of Hong Kong (CityU)

Appendix D

**Go Green Community – Jockey Club Carbon Reduction Partnership Scheme (Pilot Phase)**

Carbon Inventory of Schools (School Year 2011/12)

| No.[30] | Total Carbon Emission ($tonCO_2e$) | Emission by Scope | | | Emission Per Person[31] ($kgCO_2e$) | Emission Per Square Metre[32] ($kgCO_2e$) |
|---|---|---|---|---|---|---|
| | | Scope 1 ($tonCO_2e$) | Scope 2 ($tonCO_2e$) | Scope 3 ($tonCO_2e$) | | |
| 1 | 189.39 | 6.33 | 157.75 | 25.31 | 226.28 | 35.07 |
| 2 | 197.76 | 3.88 | 159.94 | 33.94 | 623.83 | 65.92 |
| 3 | 201.65 | 11.33 | 178.30 | 12.02 | 239.49 | 83.67 |
| 4 | 234.54 | 21.27 | 179.73 | 33.55 | 297.64 | 58.64 |
| 5 | 242.51 | 14.25 | 197.52 | 30.74 | 373.67 | 92.92 |
| 6 | 257.93 | 44.90 | 208.82 | 4.21 | 1553.81 | 55.53 |
| 7 | 261.41 | 19.30 | 212.88 | 29.23 | 405.29 | 32.68 |
| 8 | 275.36 | 15.44 | 228.76 | 31.15 | 270.76 | 91.79 |
| 9 | 286.86 | 12.99 | 228.17 | 45.70 | 344.78 | 47.81 |
| 10 | 304.38 | 11.92 | 243.89 | 48.57 | 299.29 | 68.91 |
| 11 | 307.99 | 9.54 | 253.59 | 44.86 | 339.20 | 39.49 |
| 12 | 311.20 | 29.23 | 247.57 | 34.39 | 571.00 | 51.51 |
| 13 | 319.52 | 24.41 | 240.87 | 54.25 | 461.74 | 58.10 |
| 14 | 320.86 | 14.87 | 262.31 | 43.69 | 342.80 | 105.34 |
| 15 | 332.61 | 10.46 | 280.72 | 41.43 | 1007.90 | 30.24 |
| 16 | 358.09 | 32.78 | 292.95 | 32.37 | 406.46 | 56.44 |
| 17 | 361.52 | 34.06 | 283.54 | 43.93 | 353.74 | 58.31 |
| 18 | 364.03 | 27.31 | 315.77 | 20.95 | 361.14 | 58.07 |
| 19 | 369.03 | 24.50 | 310.16 | 34.37 | 398.09 | 52.72 |
| 20 | 374.78 | 27.83 | 310.80 | 36.15 | 361.76 | 49.97 |
| 21 | 387.71 | 6.96 | 330.64 | 50.12 | 416.90 | 64.62 |
| 22 | 398.62 | 25.14 | 321.18 | 52.30 | 387.01 | 56.95 |
| 23 | 406.37 | 29.78 | 326.39 | 50.20 | 342.64 | 73.89 |
| 24 | 415.12 | 13.73 | 335.31 | 66.08 | 349.14 | 61.05 |
| 25 | 418.46 | 19.41 | 332.41 | 66.64 | 357.05 | 55.79 |
| 26 | 427.16 | 21.68 | 367.95 | 37.53 | 340.10 | 67.41 |
| 27 | 428.10 | 18.13 | 321.20 | 88.77 | 407.71 | 85.62 |
| 28 | 448.15 | 33.21 | 292.90 | 122.05 | 429.68 | 70.02 |
| 29 | 508.42 | 30.59 | 393.46 | 84.37 | 400.96 | 84.74 |
| 30 | 515.45 | 36.44 | 452.73 | 26.27 | 468.59 | 128.86 |
| 31 | 520.09 | 27.46 | 439.02 | 53.62 | 493.44 | 104.65 |
| 32 | 543.03 | 40.71 | 467.76 | 34.56 | 499.11 | 67.88 |
| 33 | 732.35 | 39.41 | 590.84 | 102.10 | 643.54 | 98.17 |

[30] Numbered in ascending order in accordance with the total carbon emission
[31] Including students, teachers and staff
[32] School site area

Appendix E

**Go Green Community – Jockey Club Carbon Reduction Partnership Scheme (Pilot Phase)**

Carbon Inventory of NGOs (Financial Year 2011/12)

| No.[33] | Total Carbon Emission ($tonCO_2e$) | Emission by Scope | | | Emission Per Person[34] ($kgCO_2e$) | Emission Per Square Metre[35] ($kgCO_2e$) |
|---|---|---|---|---|---|---|
| | | Scope 1 ($tonCO_2e$) | Scope 2 ($tonCO_2e$) | Scope 3 ($tonCO_2e$) | | |
| 1 | 22.35 | 3.34 | 17.87 | 1.15 | 1490.15 | 64.98 |
| 2 | 54.30 | 3.06 | 50.93 | 0.32 | 3016.82 | 62.20 |
| 3 | 66.98 | 2.29 | 60.57 | 4.12 | 2309.51 | 90.14 |
| 4 | 69.52 | 3.36 | 60.30 | 5.86 | 2574.98 | 160.19 |
| 5 | 104.43 | 27.09 | 77.34 | 0.00 | 1740.48 | 80.95 |
| 6 | 185.47 | 29.38 | 150.70 | 5.39 | 5012.67 | 114.35 |
| 7 | 334.07 | 8.67 | 321.13 | 4.26 | 7262.35 | 95.83 |
| 8 | 468.64 | 47.77 | 410.30 | 10.58 | 3471.40 | 70.71 |

[33] Numbered in ascending order in accordance with the total carbon emission
[34] Staff only; clients not included (as number of clients may vary greatly depending on nature of service)
[35] Gross floor area